

# Memorandum: CPPD's Use of Emissions Factors from eGRID and AVERT

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## Introduction

EPA's Climate Protection Partnerships Division (CPPD) promotes voluntary partnerships and develops programs and products to reduce greenhouse gas (GHG) emissions through the adoption of energy efficiency and renewable energy (EE/RE) programs. To communicate the positive impact these EE/RE programs have on reducing carbon pollution and mitigating climate change, CPPD uses emissions factors that relate changes in electric power generation to corresponding changes in carbon dioxide (CO<sub>2</sub>) emissions. Other EPA offices also use this type of emissions factor to calculate and communicate the carbon pollution impacts of programs and policies that affect electric power generation or consumption.

This memorandum serves five purposes:

- Provide an overview of CPPD's two main sources of emissions factors: eGRID and AVERT.
- Describe the relative merits and appropriate uses of eGRID and AVERT emissions factors.
- Explain why CPPD has chosen to use AVERT as the appropriate source for emissions factors for calculating program benefits in the division's Annual Report.
- Survey other CPPD and EPA programs and tools to understand their current emissions factor assumptions.
- Provide a basis for CPPD programs and others to justify the use of different emissions factors across their tools, depending on the purpose of each tool.

## Background on eGRID and AVERT

### *eGRID*

In 2004, E.H. Pechan & Associates, Inc. developed the Emissions and Generation Resource Integrated Database (eGRID) for EPA. eGRID was designed to compile CO<sub>2</sub>, NO<sub>x</sub>, SO<sub>2</sub> and mercury emissions data for the electric power generated in the United States. The most recent eGRID data are available from the eGRID website, <http://www2.epa.gov/energy/egrid>.

Data in eGRID are aggregated into subregions that are identified and defined by EPA, using the North American Electric Reliability Corporation (NERC) regions and Power Control Areas as a guide. eGRID data are also displayed at the plant level and aggregated to state, electric generating company (EGC), parent company, power control area (PCA), NERC region, and U.S. total levels. Information about the boilers and generators associated with the eGRID plants is also included in the eGRID data set.

eGRID provides three types of annual output emissions rates, each calculated differently and intended for different purposes: annual [total] output emissions rates, annual fossil fuel output emissions rates, and annual non-baseload output emissions rates:

- **Total output emissions rates** measure emissions as they relate to net generation output. The rate is calculated as total annual emissions divided by the total MWh generated in a given region.
- **Fossil fuel output emissions rates** measure emissions per MWh for specific fuel sources, based on

each electric generating unit's (EGU's) primary fuel. All fossil fuels are aggregated for the overall fossil fuel output emissions rate.

- **Non-baseload output emissions rates** are calculated from the generation and emissions of EGUs that have annual capacity factors<sup>1</sup> less than 80%. EGUs with annual capacity factors greater than 80% are not included in the non-baseload emissions rate. This approach approximates the emissions profile of marginal EGUs—i.e., those that are most likely to be affected by policies and programs that affect electricity supply or demand at peak times.

## *AVERT*

In 2013, Synapse Energy Economics developed the AVOIDed Emissions and geneRation Tool (AVERT) for EPA to help state and other users estimate the CO<sub>2</sub>, NO<sub>x</sub> and SO<sub>2</sub> emissions impacts of EE/RE programs and incorporate them into state implementation plans (SIPs) for the National Ambient Air Quality Standards. AVERT users can analyze how different types of EE programs, as well as wind, geothermal and solar technologies, affect the magnitude and location of emissions at county, state, regional, and national levels.

AVERT works by estimating the “displaced generation” from EE/RE programs—that is, the generation at fossil fuel power plants that will not take place because EE or RE is meeting consumers’ energy needs. Specific EE/RE programs and technologies have hourly load profiles, which are hour-by-hour schedules of expected reductions in electricity demand or increases in electricity production over the course of year. Understanding the hour-by-hour relationship between specific EE/RE programs and the dispatch of fossil fuel EGUs (that is, which power plants are called on to generate electricity in a given hour) is essential to the estimation of the magnitude and location of emissions reductions from EE/RE.

The AVERT method uses historical hourly emissions rates based on recent EPA data on EGUs’ hourly generation and emissions reported through EPA’s Acid Rain Program. This method couples historical hourly generation and emissions with the hourly load reduction profiles of EE/RE resources to determine hourly marginal emissions rates and hourly emissions reductions. AVERT can be used to predict EE/RE-related emissions reductions in a current or near-future year—though it is based on historical behavior rather than predicted economic behavior, and therefore does not use projections of future fuel or electricity market prices.

## When to use eGRID or AVERT

### *eGRID*

The three types of emissions factors from eGRID are all estimated annual averages, but they serve distinct purposes:

- **Total output emissions rates** are used for greenhouse gas inventory development, carbon footprinting, registry protocols, and other applications that value total electricity use on an annual basis. These rates are the primary rates to use when determining “scope 2” emissions from the consumption of purchased electricity.
- **Fossil fuel output emissions rates** are used to estimate avoided emissions from resources that would displace grid-supplied electricity. These rates are best used to estimate emissions reductions for resources that displace grid-supplied electricity around the clock or when the grid is operating at

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<sup>1</sup> Capacity factors describe how intensively an EGU is run. A capacity factor near 100% means an EGU is operating at full capacity nearly all of the time. It is the ratio of actual generation to maximum potential generation.

baseload conditions, such as combined heat and power (CHP) units or energy-efficient traffic light upgrades.

- **Non-baseload output emissions rates** are primarily used to estimate displaced emissions from EE/RE programs. These rates best capture emissions reductions that coincide with peak energy demand. These rates are less appropriate for determining the benefits of resources that operate intermittently, such as wind power, as these resources do not necessarily coincide with times of peak demand.<sup>2</sup>

## AVERT

AVERT is best suited to analyze the emissions impacts of statewide or multi-state EE/RE policies and programs. It combines historical hourly generation data with EE/RE load impact profiles, making it possible for users to compare emissions benefits of different EE/RE programs. For example, wind and solar power have different hourly and seasonal operational profiles. AVERT can compare the emissions impacts between these two RE technologies at different times of the year. Similarly, various EE programs have different hourly load profiles. AVERT can help users analyze different EE programs or portfolios of programs that offer different energy savings and emissions displacement throughout the year. Using this information, air quality planners could, for example, assess which EE programs provide the greatest air quality improvement on high ozone days.

AVERT has many applications, including:

- Calculating credits for State Implementation Plans (SIPs) or Tribal Implementation Plans (TIPs) for National Ambient Air Quality Standards nonattainment zones.
- Serving as a screening tool for EPA's Clean Power Plan.
- Analyzing NO<sub>x</sub>, SO<sub>2</sub> and CO<sub>2</sub> emissions impacts of an EE/RE program portfolio.
- Comparing emissions impacts between different EE/RE resources.
- Identifying locations of emissions reductions at the regional, state, and county levels.
- EGU representation also available.
- Promoting emissions benefits of EE/RE with easy-to-interpret maps and charts.

Because AVERT modeling is conducted in 10 large regions that represent electricity markets, and it does not account for transmission constraints within each region, this tool is not recommended for estimating the emissions displaced by small or local programs. AVERT is also not a projection tool; it is not intended for analysis more than five years from the baseline period.

## Emissions Factors for CPPD's Annual Report

In September 2015, CPPD decided to update the CO<sub>2</sub> emissions factor for reporting program benefits in the Office of Atmospheric Programs (OAP) Climate Protection Partnerships Annual Report. CPPD made this update so that the CO<sub>2</sub> emissions impacts apply the best available emissions factor assumptions and reflect current electricity market conditions. CPPD managers evaluated emissions factors from eGRID and AVERT; after careful consideration, they chose AVERT.

CPPD decided to use AVERT for the following reasons:

- AVERT has more recent data and is updated annually. The most recent year in AVERT is 2014, whereas eGRID's data are from 2012 and they are updated every two to three years, with a three- to four-year

<sup>2</sup> Rothschild et al. 2009. The Value of eGRID and eGRIDweb to GHG Inventories.  
<http://www3.epa.gov/statelocalclimate/documents/pdf/TheValueofeGRID.pdf>.

lag. AVERT's updates are low-cost and are certain to continue.

- AVERT provides a national or regional emissions factor that represents a portfolio of programs, reflective of ENERGY STAR® products and programs. It also can generate emissions factors specific to wind and solar programs.
- eGRID's non-baseload emissions rate is a one-size-fits-all, annual non-baseload rate that uses the annual level plant-level capacity factor as a rule of thumb. In contrast, AVERT is an intermediate methodology with a more granular data set. It uses a statistical approach based on actual power plant dispatch behavior from a historical year. AVERT's methodology has been benchmarked against a market analytic industry-grade dispatch model and demonstrates similar results to MISO and PJM market reports of marginal units.
- Although AVERT's data set is not as comprehensive as eGRID, it is only missing 2% of total CO<sub>2</sub> emissions from units less than 25MW.

## Tools and Programs that Use eGRID and AVERT

Tool	eGRID			AVER T	Other	Notes
	Total Output	Fossil Fuel	Non- Baseload			
CPPD Tools and Resources						
OAP’s Climate Protection Partnerships Annual Report				✓		
<a href="#">Power Profiler</a>	✓					
<a href="#">Climate Leaders</a>	✓					
<a href="#">ENERGY STAR Portfolio Manager and Target Finder</a>	✓					
<a href="#">Greenhouse Gas Equivalencies Calculator</a>			✓			
<a href="#">Green Power Equivalency Calculator</a>			✓			
<a href="#">Combined Heat and Power Emissions Calculator</a>		✓	✓			CHPP encourages the use of the eGRID fossil factor for baseload CHP (>6,500 annual operating hours) and the non-baseload factor for CHP systems with <6,500 hours and with most generation occurring during periods of high demand.
Regional Comparison of Wind, Solar, and EE Programs (CPPD and Synapse Energy Economics, April 2015)				✓		
Other EPA Tools and Resources						
<a href="#">Carbon Footprint Calculator (CCD)</a>	✓					

<u>Landfill Methane Outreach Program (LMOP) LFG Energy Benefits Calculator (CCD)</u>					✓	LMOP uses an emissions factor from a November 2004 CPPD memo entitled “Estimates of the National Average Displaced Emission Rate Estimates,” adjusted downward each year.
<u>Ozone Advance Program (OAQPS)</u>				✓		
<u>Light Duty Vehicle Greenhouse Gas Regulations and the Electric Vehicle Compliance Factor (OTAQ)</u>	✓				✓	The model year 2012–2016 rule uses eGRID. The model year 2017–2025 rule largely uses IPM.
<u>SmartWay Tools for electric vehicles (OTAQ)</u>					✓	These tools use life-cycle emissions factors from GREET (see below), which uses data from EIA.
<u>Waste Reduction Model (WARM) (OSWER)</u>			✓			
<u>WasteWise annual reporting (OSWER)</u>			✓			The program uses WARM.
<u>WasteWise Office Carbon Footprint Tool (OSWER)</u>	✓					
<u>WaterSense (OW)</u>			✓			WaterSense uses factors from CPPD’s Greenhouse Gas Equivalencies Calculator, which comes from eGRID.
<u>Steam electric effluent guidelines rulemaking: Analysis of non-water quality environmental Impacts</u>					✓	IPM
<u>E3: Economy – Energy – Environment (ORD)</u>			✓			
<u>Regionalized Electricity Life Cycle Inventory (ORD, in development)</u>	✓					Emissions factors are aggregated from eGRID’s individual facility data.
<u>Green Engineering Materials Management (GEMM) tool (OCSPP, in development)</u>	✓					This tool uses NREL’s Life Cycle Inventory Database, which is based in part on eGRID.
<b><i>Other Federal Tools and Resources</i></b>						

<a href="#">Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation Model (GREET) model</a> (Argonne National Laboratory)					✓	This life cycle model uses fuel-specific factors and the national fuel mix as reported by EIA. Prior versions used eGRID.
<a href="#">Alternative Fuels Data Center's Emissions from Hybrid and Plug-In Electric Vehicles calculator</a> (DOE)					✓	The regional fuel mix comes from eGRID, but life-cycle emissions factors come from GREET (see above), which uses data from EIA.
<a href="#">Carbon Storage Atlas</a> (DOE)						eGRID (exact factor TBD)
<a href="#">Online Smart Grid Computational Tool</a> (DOE)				✓		
<a href="#">HOMER Microgrid Modeling Software</a> (NREL)						eGRID (exact factor TBD)
<a href="#">Life Cycle Inventory Database</a> (NREL)	✓					This resource typically uses total emissions from eGRID.
Federal Transit Administration's <a href="#">Carbon Calculator</a> (DOT)						eGRID (exact factor TBD)
<b>Non-Federal Tools and Resources</b>						
American Wind Association's <a href="#">The Clean Air Benefits of Wind Energy</a>				✓		
Maine Public Utilities Commission's <a href="#">Maine Distributed Solar Valuation Study</a>				✓		
The Alliance to Save Energy's <a href="#">CarbonCount™</a>				✓		
<a href="#">The Climate Registry and the California Climate Action Registry's Reporting Protocols</a>	✓					
WRI and WBCSD Greenhouse Gas Protocol <a href="#">Emissions Calculators</a>	✓?					eGRID (exact factor TBD)
PJM Interconnection's <a href="#">Generation Attribute Tracking System</a>						eGRID (exact factor TBD)
New England Power Pool's <a href="#">Generation Information System</a>						eGRID (exact factor TBD)

International Council for Local Environmental Initiatives' <u>Air and Climate Protection Software</u>						eGRID (exact factor TBD)
Carbonfund.org's <u>Emissions Calculators</u>						eGRID (exact factor TBD)